

TOSHIBA BIPOLAR DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

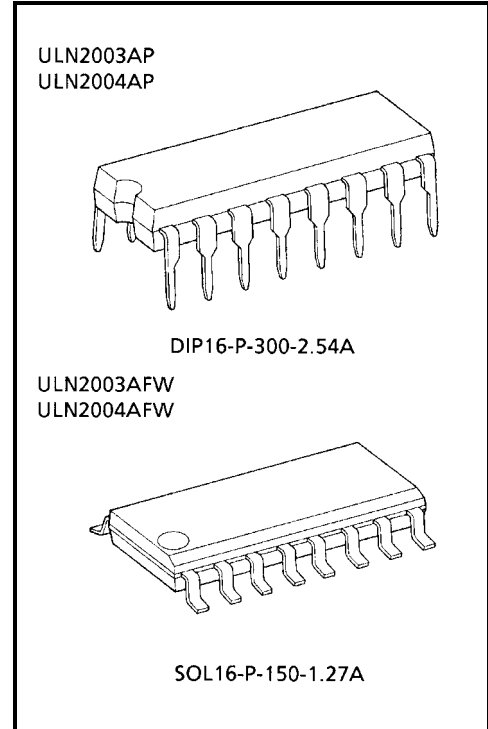
## ULN2003AP,ULN2003AFW,ULN2004AP,ULN2004AFW (Manufactured by Toshiba Malaysia)

### 7CH DARLINGTON SINK DRIVER

The ULN2003AP / AFW Series are high-voltage, high-current darlington drivers comprised of seven NPN darlington pairs. All units feature integral clamp diodes for switching inductive loads. Applications include relay, hammer, lamp and display (LED) drivers.

### FEATURES

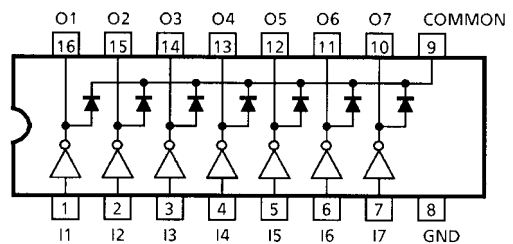
- Output current (single output) 500 mA MAX.
- High sustaining voltage output  
50 V MIN.
- Output clamp diodes
- Inputs compatible with various types of logic
- Package Type-AP : DIP-16pin
- Package Type-AFW : SOL-16pin



Weight  
 DIP16-P-300-2.54A : 1.11 g (Typ.)  
 SOL16-P-150-1.27A : 0.15 g (Typ.)

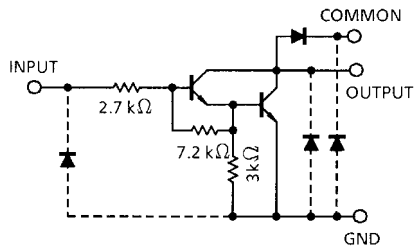
### PIN CONNECTION (TOP VIEW)

TYPE	INPUT BASE RESISTOR	DESIGNATION
ULN2003AP / AFW	2.7 kΩ	TTL, 5 V CMOS
ULN2004AP / AFW	10.5 kΩ	6~15 V PMOS, CMOS

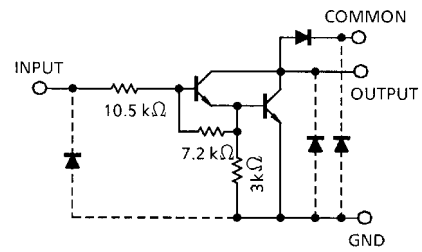


## SCHEMATICS (EACH DRIVER)

ULN2003AP / AFW



ULN2004AP / AFW



Note: The input and output parasitic diodes cannot be used as clamp diodes.

## MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Output Sustaining Voltage	$V_{CE(SUS)}$	-0.5~50	V
Output Current	$I_{OUT}$	500	mA / ch
Input Voltage	$V_{IN}$	-0.5~30	V
Clamp Diode Reverse Voltage	$V_R$	50	V
Clamp Diode Forward Current	$I_F$	500	mA
Power Dissipation	AP	1.47	W
	AFW	0.54 / 0.625 (Note)	
Operating Temperature	$T_{opr}$	-40~85	°C
Storage Temperature	$T_{stg}$	-55~150	°C

Note: On glass epoxy PCB (30 × 30 × 1.6 mm Cu 50%)

## RECOMMENDED OPERATING CONDITIONS (Ta = -40~85°C)

CHARACTERISTIC		SYMBOL	TEST CONDITION		MIN	TYP.	MAX	UNIT
Output Sustaining Voltage		V <sub>CE (SUS)</sub>			0	—	50	V
Output Current	AP	I <sub>OUT</sub>	T <sub>pw</sub> = 25 ms 7 Circuits	Duty = 10%	0	—	370	mA / ch
				Duty = 50%	0	—	130	
	AFW		T <sub>a</sub> = 85°C	Duty = 10%	0	—	233	
			T <sub>j</sub> = 120°C	Duty = 50%	0	—	70	
Input Voltage		V <sub>IN</sub>			0	—	24	V
Input Voltage (Output On)	ULN2003A	V <sub>IN (ON)</sub>	I <sub>OUT</sub> = 400 mA h <sub>FE</sub> = 800		2.8	—	24	V
	ULN2004A				6.2	—	24	
Input Voltage (Output Off)	ULN2003A	V <sub>IN (OFF)</sub>			0	—	0.7	V
	ULN2004A				0	—	1.0	
Clamp Diode Reverse Voltage		V <sub>R</sub>			—	—	50	V
Clamp Diode Forward Current		I <sub>F</sub>			—	—	350	mA
Power Dissipation	AP	P <sub>D</sub>	T <sub>a</sub> = 85°C		—	—	0.76	W
	AFW		T <sub>a</sub> = 85°C (Note)		—	—	0.325	

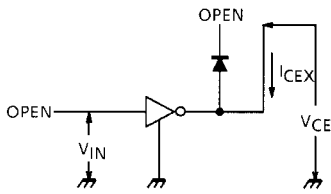
Note: On glass epoxy PCB (30 × 30 × 1.6 mm Cu 50%)

## ELECTRICAL CHARACTERISTICS (Ta = 25°C unless otherwise noted)

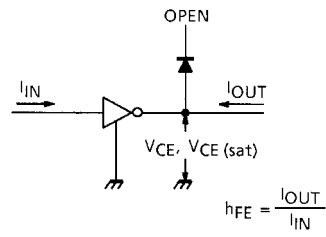
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT	
Output Leakage Current		I <sub>CEX</sub>	1	V <sub>CE</sub> = 50 V, Ta = 25°C	—	—	50	μA	
				V <sub>CE</sub> = 50 V, Ta = 85°C	—	—	100		
Collector-Emitter Saturation Voltage		V <sub>CE (sat)</sub>	2	I <sub>OUT</sub> = 350 mA, I <sub>IN</sub> = 500 μA	—	1.3	1.6	V	
				I <sub>OUT</sub> = 200 mA, I <sub>IN</sub> = 350 μA	—	1.1	1.3		
				I <sub>OUT</sub> = 100 mA, I <sub>IN</sub> = 250 μA	—	0.9	1.1		
DC Current Transfer Ratio		h <sub>FE</sub>	2	V <sub>CE</sub> = 2 V, I <sub>OUT</sub> = 350 mA	1000	—	—		
Input Current (Output On)	ULN2003A	I <sub>IN (ON)</sub>	3	V <sub>IN</sub> = 2.4 V, I <sub>OUT</sub> = 350 mA	—	0.4	0.7	mA	
	ULN2004A			V <sub>IN</sub> = 9.5 V, I <sub>OUT</sub> = 350 mA	—	0.8	1.2		
Input Current (Output Off)		I <sub>IN (OFF)</sub>	4	I <sub>OUT</sub> = 500 μA, Ta = 85°C	50	65	—	μA	
Input Voltage (Output On)	ULN2003A	V <sub>IN (ON)</sub>	5	V <sub>CE</sub> = 2 V h <sub>FE</sub> = 800	I <sub>OUT</sub> = 350 mA	—	—	2.6	V
					I <sub>OUT</sub> = 200 mA	—	—	2.0	
	ULN2004A				I <sub>OUT</sub> = 350 mA	—	—	4.7	
					I <sub>OUT</sub> = 200 mA	—	—	4.4	
Clamp Diode Reverse Current		I <sub>R</sub>	6	V <sub>R</sub> = 50 V, Ta = 25°C	—	—	50	μA	
				V <sub>R</sub> = 50 V, Ta = 85°C	—	—	100		
Clamp Diode Forward Voltage		V <sub>F</sub>	7	I <sub>F</sub> = 350 mA	—	—	2.0	V	
Input Capacitance		C <sub>IN</sub>	—		—	15	—	pF	
Turn-On Delay		t <sub>ON</sub>	8	V <sub>OUT</sub> = 50 V, R <sub>L</sub> = 125 Ω C <sub>L</sub> = 15 pF	—	0.1	—	μs	
Turn-Off Delay		t <sub>OFF</sub>	8	V <sub>OUT</sub> = 50 V, R <sub>L</sub> = 125 Ω C <sub>L</sub> = 15 pF	—	0.2	—		

## TEST CIRCUIT

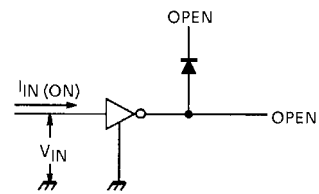
### 1. $I_{CEX}$



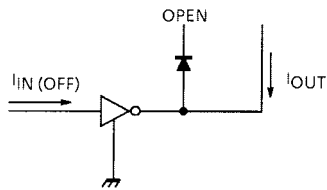
### 2. $V_{CE(sat)}$ , $h_{FE}$



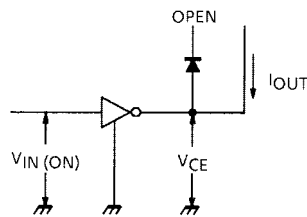
### 3. $I_{IN(ON)}$



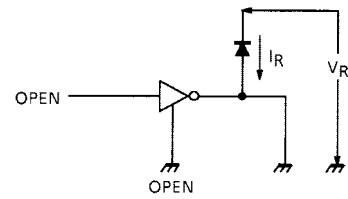
### 4. $I_{IN(OFF)}$



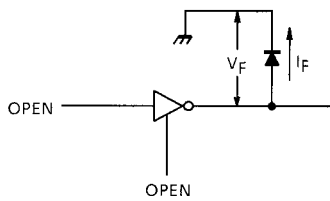
### 5. $V_{IN(ON)}$



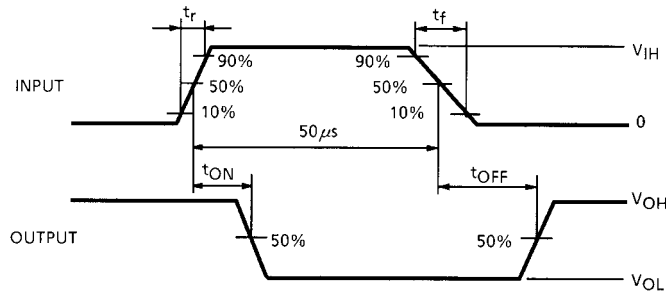
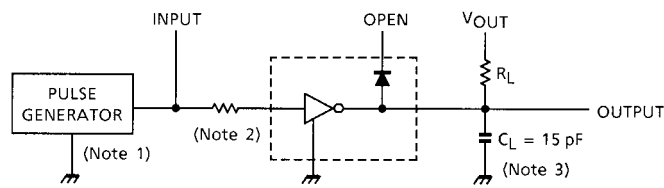
### 6. $I_R$



### 7. $V_F$



**8.  $t_{ON}$ ,  $t_{OFF}$**



- Note 1: Pulse width 50  $\mu$ s, duty cycle 10%  
Output impedance 50  $\Omega$ ,  $t_r \leq 5$  ns,  $t_f \leq 10$  ns
- Note 2: See below

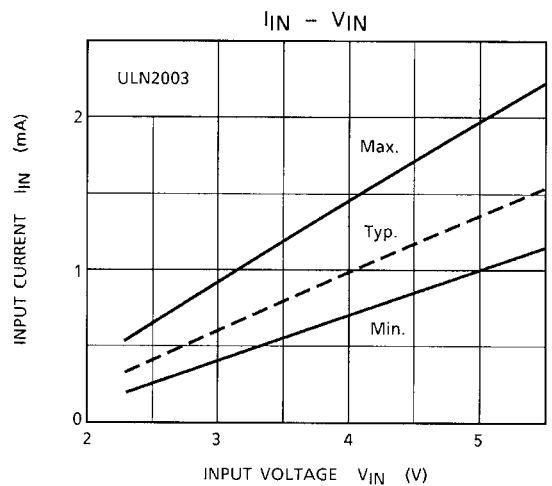
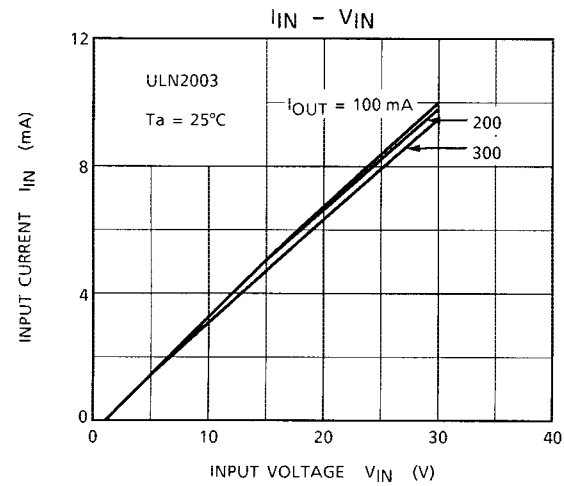
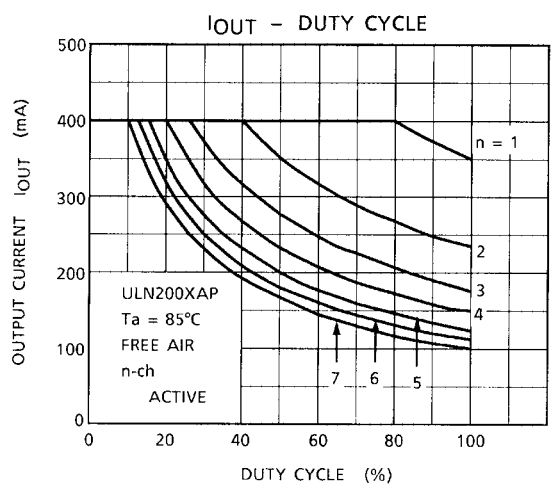
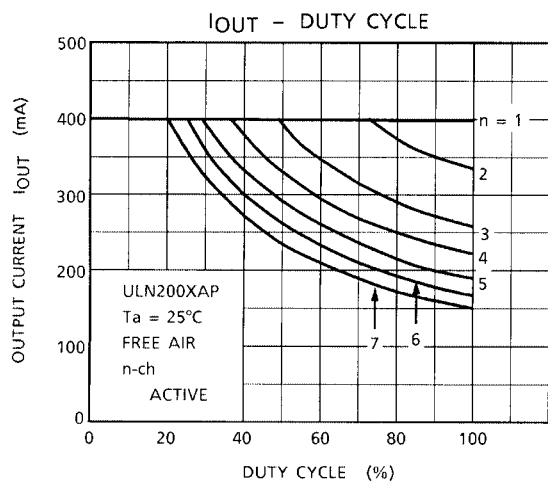
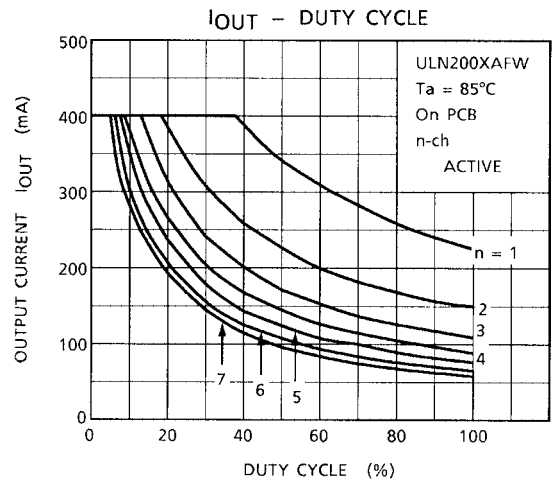
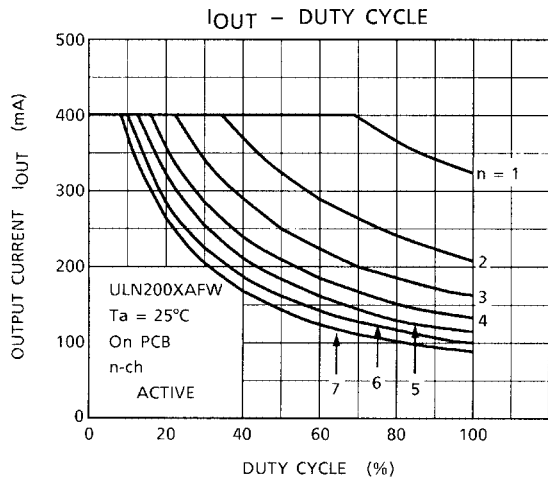
**INPUT CONDITION**

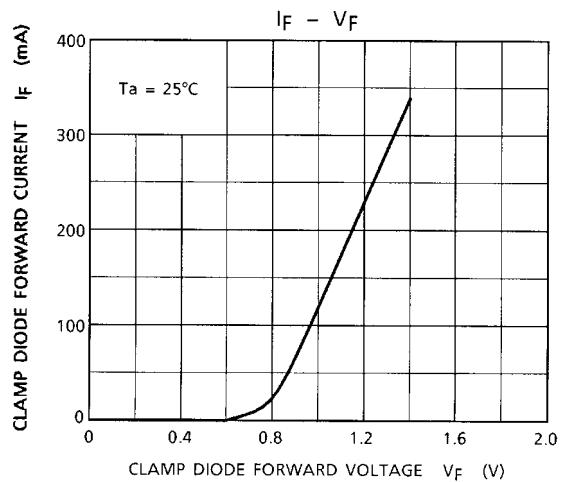
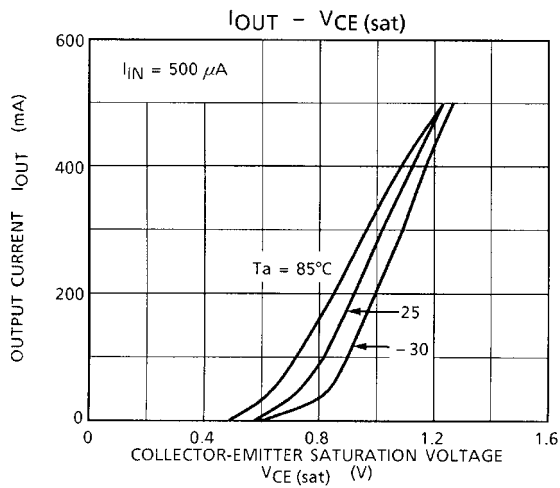
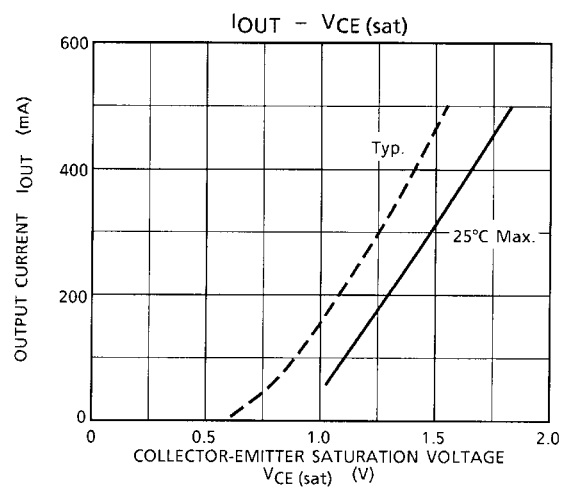
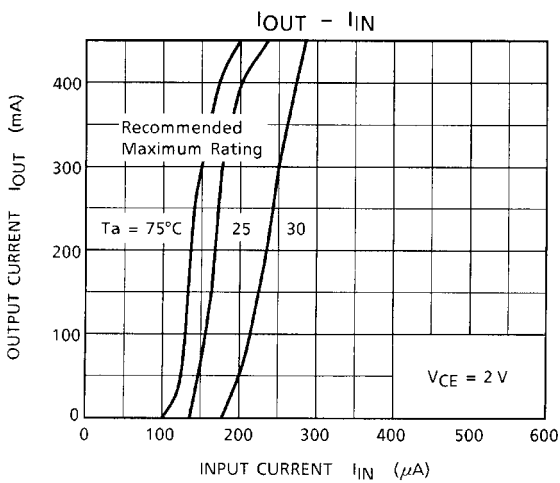
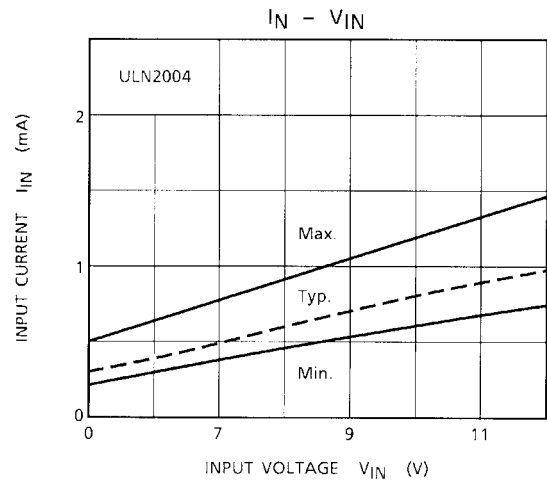
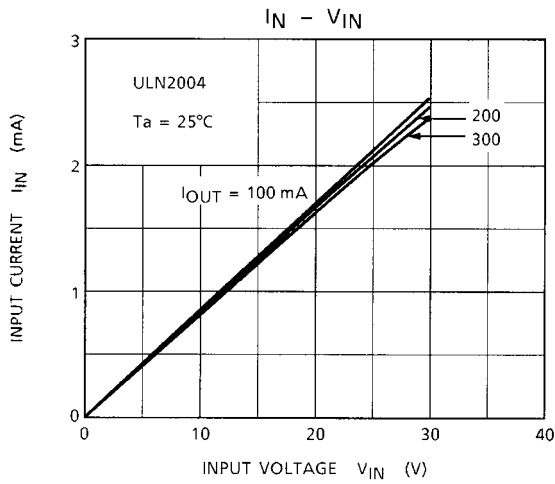
TYPE NUMBER	R1	$V_{IH}$
ULN2003AP / AFW	0	3 V
ULN2004AP / AFW	0	8 V

Note 3:  $C_L$  includes probe and jig capacitance.

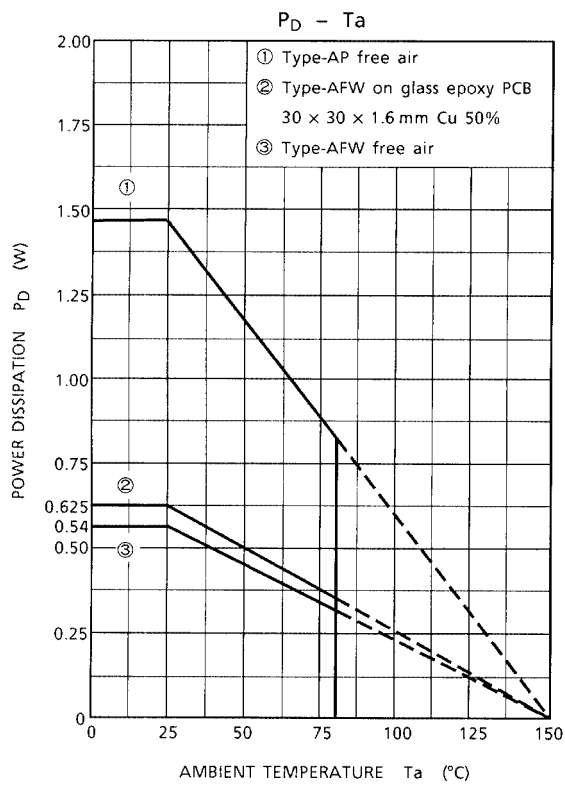
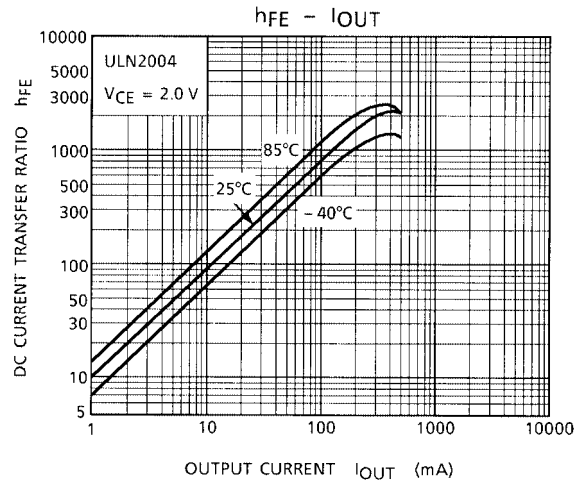
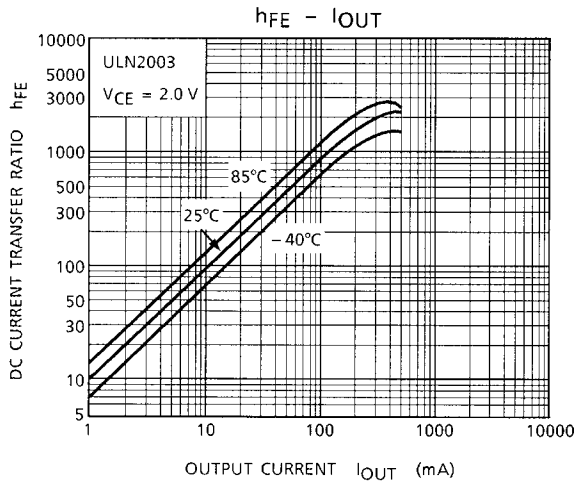
**PRECAUTIONS for USING**

This IC does not include built-in protection circuits for excess current or overvoltage. If this IC is subjected to excess current or overvoltage, it may be destroyed. Hence, the utmost care must be taken when systems which incorporate this IC are designed. Utmost care is necessary in the design of the output line, COMMON and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.



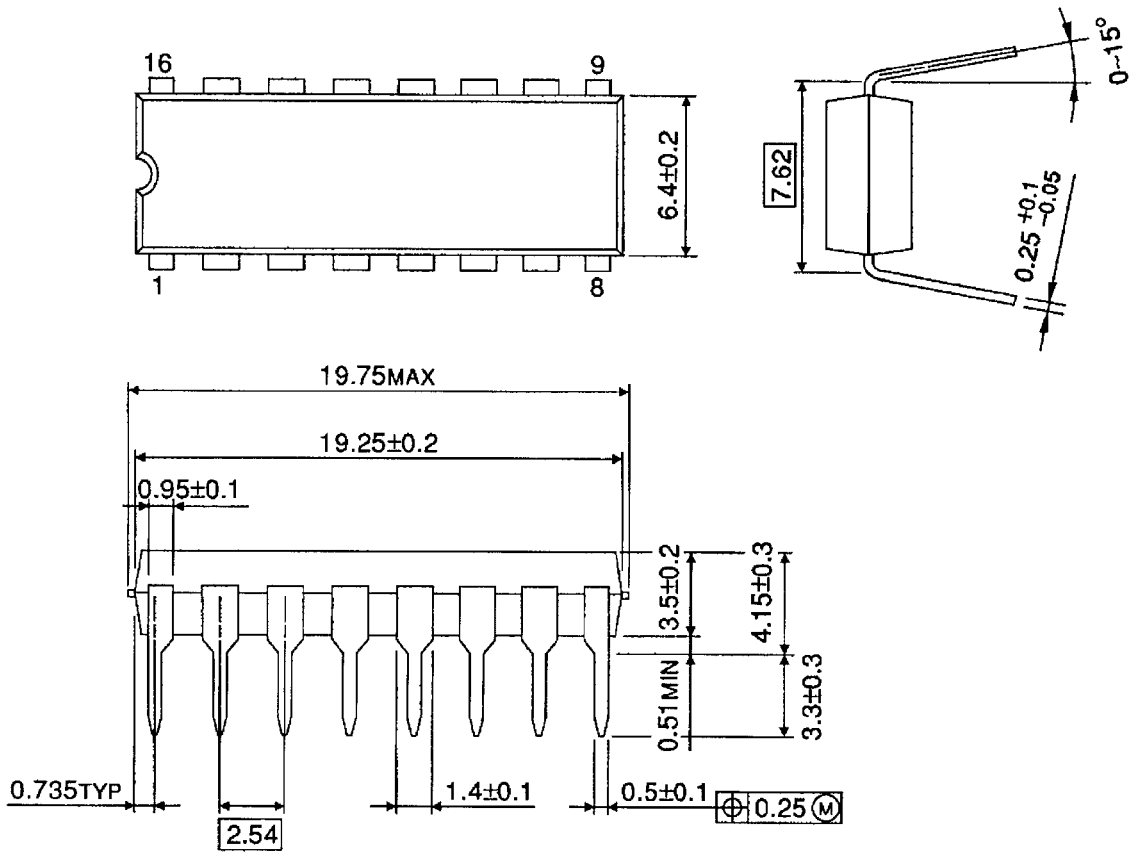






## PACKAGE DIMENSIONS

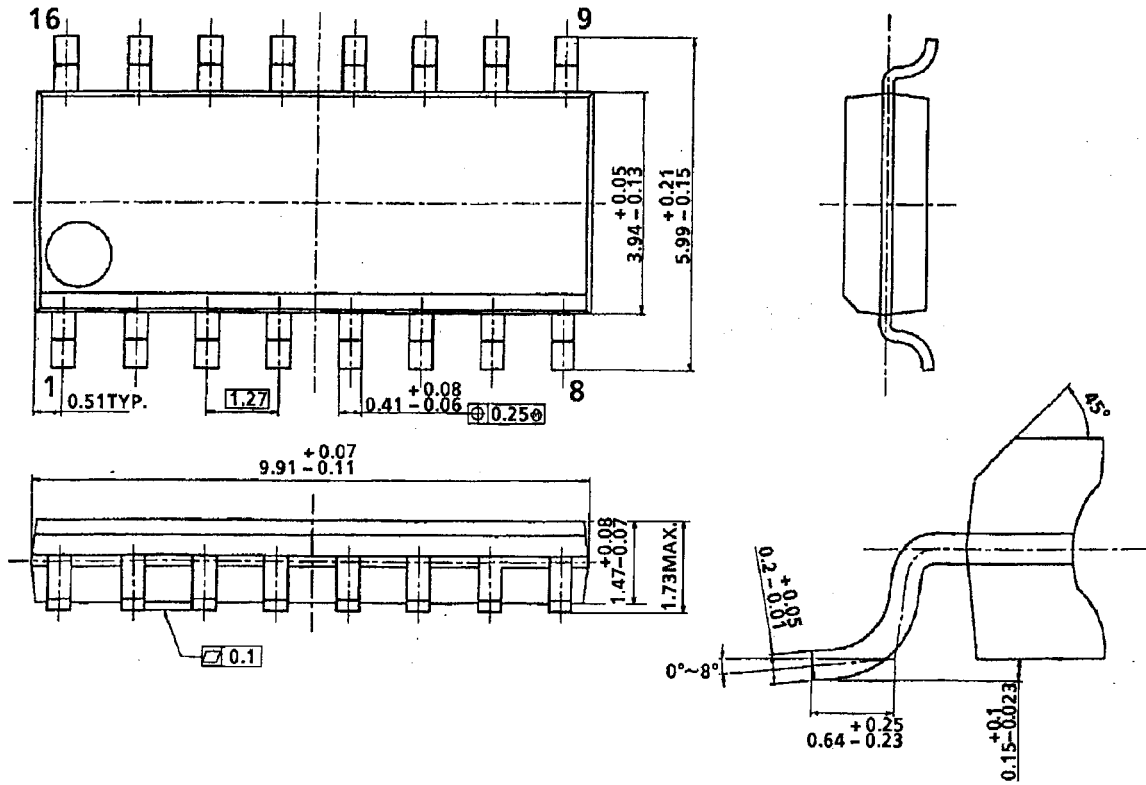
DIP16-P-300-2.54A



Weight: 1.11 g (Typ.)

## PACKAGE DIMENSIONS

SOL16-P-150-1.27A



Weight: 0.15 g (Typ.)

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000707EBA

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Datasheets for electronics components.